U.S. ARMY COST ANALYSIS HANDBOOK

SECTION 12

COST RISK AND UNCERTAINTY ANALYSIS

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Section 12.1 – Introduction

The purpose of Cost Risk and Uncertainty Analysis is to estimate resources required to meet specified requirements and performance objectives. Without risk analysis, a cost estimate will usually be a single value, called a point estimate, which does not account for the uncertainties inherent in the effort. Cost Risk and Uncertainty Analysis identifies the cost, in terms of dollars, time, and materials that should be added to a point estimate to increase the probability of meeting the desired outcome. Cost Risk and Uncertainty Analysis communicates to decision makers how specific uncertainties contribute to overall cost and schedule risk. Without this analysis, costs and schedules tend to be understated. Ignoring potential uncertainties can cause underfunding, cost overruns, and a risk of a program being reduced in scope or of requiring additional funding to meet its objectives. It is the analyst's responsibility to inform the decision maker about cost and schedule risk. The analyst should present the decision maker with a cost and schedule estimate that has an acceptable confidence level for success when considering the risks. In the end, the decision makers can decide to accept risk; but analysts must ensure decision makers understand the risk they are accepting.

This Section provides guidance on the process of Cost Risk and Uncertainty Analysis. It is divided into three sections:

- *Identifying Uncertainty* defines key terms and provides a straightforward process for highlighting and categorizing a program's underlying uncertainties.
- *Quantifying Uncertainty* provides guidance for modeling program uncertainties into well-defined distributions that will be used to formulate a spectrum of the overall cost variability.
- *Presenting Risk and Uncertainty* offers ideas on how to present an analysis of cost risk and uncertainty to various potential audiences. It then provides guidance for displaying and phasing "Risk Dollars" within an estimate.

Section 12.2 – Identifying Uncertainty

(1) Risk and Uncertainty

Before performing an analysis of cost uncertainty and risk, it is necessary to clarify a technical definition for the two terms:

Risk is the probability of an unfavorable outcome occurring. In cost analysis, risk is the probability of overrunning the estimated cost. *Uncertainty* is the indefiniteness about the outcome of a situation. Uncertainty is assessed in cost estimate models for the purpose of estimating the risk (probability) that a specific funding level will be exceeded. Cost uncertainty analysis is a process of identifying and quantifying the uncertainties associated with elements of the cost estimate such as cost estimating relationships (CERs), factors, technical parameters that drive CERs, labor rates, and schedules.

(2) Useful Sources for Identifying Uncertainty

If the cost analyst is required to estimate cost variance, one of the first steps should be to examine several documents to *identify* any areas where variance may have an impact on future costs. The following resources contain some of the information needed to identify the risks and uncertainties associated with the future of a program:

- Cost Analysis Requirements Description (CARD)
- Initial Capabilities Document (ICD) / Capability Development Document (CDD) / Capability Production Document (CPD)
- Program's Risk Assessment
- Technology Development Strategy
- Acquisition Strategy
- Analysis of Alternatives
- Test and Evaluation Master Plan
- Engineers and Subject Matter Experts (SMEs)
- Cost and Performance Reports from analogous systems

(3) Categorizing Uncertainty

As uncertainties are identified, they can be categorized as either *internal* or *external* to the program. *Internal elements of uncertainty* can be represented within an estimate by defining distributions for the estimate's underlying variables. *External elements of uncertainty* tend to be more difficult to represent by probability distributions. When their impacts are examined, it is generally by sensitivity analysis.

Internal Elements of Uncertainty
Technical Variance is the variation of costs due to the evolution of a new design, which provide a greater level of performance than has previously been demonstrated. This includes all development and implementation of changes, which increase the capabilities of the produced system. Both hardware and software changes are technical changes.
Schedule Variance is cost variance due to changes in the schedule, derived from technical challenges and issues with whether the program has the correct personnel in place to complete specific tasks on schedule. This variation is especially an issue when a program schedules many interrelated activities concurrently.
Cost Estimating Variance is the variation of costs from the level predicted by the data and methodologies used. This may be due to variance within the estimate's adjustment factors, cost estimating relationships (CERs), learning curve slopes, estimates done by experts, etc.
External Elements of Uncertainty
Programmatic Variance is variance related to issues and events outside of the program's control that can still impact the program's future. Such variance may be caused by program decisions

made at higher levels of authority, indirect events affecting the program, or other unforeseen events that are largely unpredictable.
Requirements Variance is the variance related to potential changes in system requirements. Some critical parameters of a program that fall in this category are design specifications, software requirements, fielding strategy, and procurement quantities.
Budget and Economic Variance is the variance related to future funding and key business assumptions made by the program. Some specific uncertainties in this category are based on changes to future funding levels, supplier viability, inflation indices, and market conditions.

(4) Addressing Uncertainties within Cost Estimates

Before beginning the process by which uncertainties can be addressed mathematically within a cost estimate, the estimator must determine at what level of an estimate to analyze them. Uncertainty assessment is best done at the lowest-level variables. It is easier to develop a probabilistic description of an uncertainty if the uncertainty is more specific. It is also easier to keep track of which uncertainties have been addressed. The only times uncertainties should be calculated at an aggregated level are when the available data do not allow them to be broken down. Uncertainties should be addressed when point estimates are developed, rather than added in later.

The estimating methodology determines which particular elements are subject to risk analysis. For example, if part of Prototype Manufacturing is estimated using a CER to produce a cost estimate for some hardware component, the characteristics of the CER determine how the risk analysis should be done. Any CER will have some variance between predicted costs, and the actual costs in the data from which the CER was generated. This will be one element of uncertainty. Another element of variance (which will be much harder to assess), will be the applicability of the CER. It is unusual for the data behind the CER to precisely represent the item being estimated. Any difference between the new item, and the items in the data set, creates a source of variance between the CER's prediction, and the actual result. Ideally, this variance should be considered in any risk analysis.

The various parameters in the CER may also be sources of risk or uncertainty. If physical parameters of the object are used, these parameters may or may not be certain. When the duration of a future schedule is used, the possibility of a schedule shift will introduce variance in the CER result; the situation will determine whether it is feasible to estimate the probability distribution of the actual schedule. When a CER uses software code size as an input, the variation in the possible size of the resultant code introduces variability in the CER's output estimate. These are only possibilities; the factors which will actually introduce risk and uncertainty depend on the methodology used and on the particular situation.

When one element is estimated as a factor times another—such as when a step factor is used to estimate prototyping from production—the two elements of the variance of the estimated element are the values of the source estimate, and the value of the ratio. Variance in the source element is best calculated with the source element. The variance which should be estimated at the derived element is the variance in the step factor. A distribution for the step factor may be estimated from the data which were used to derive it.

When risks and uncertainties for the lowest-level variables cannot be defined, it may be possible to capture them at an intermediate level (located on a parent-level cost cell with defined children). In this case, the lower-level variables should only be defined by point estimates because the overall effect of the lower-level variance is being described at the parent level. This method may be used if much of the variance around the children is unknown and the analyst has some justifiable idea of what the parent's risk distribution would look like.

Section 12.3 – Quantifying Risk and Uncertainty

(1) Where Can Variance Be Modeled?

Quantifying risk is a complex mathematical process. The following software packages allow the user to input risk distributions and then produce a Cost Risk and Uncertainty Analysis.

a. Automated Cost Estimating Integrated Tools – ACEIT (www.aceit.com) – Directly integrated within ACEIT is a simulation-based risk analysis capability (RI$K) that allows the analyst to perform cost, schedule, and technical risk and uncertainty analysis. This software provides the capability to calculate risk results for various confidence levels using Latin-Hypercube sampling, with Monte Carlo selection of the data-point within each hypercube partition. After running the simulations, the analyst can select the appropriate confidence level and time-phase the risk-adjusted result.

b. @RISK (www.hearne.com.au) – @Risk interfaces with Excel and allows insight into the possible outcomes of an estimate and the likelihood of each particular outcome.

c. Crystal Ball (www.crystalball.com) – Crystal Ball is a suite of Excel-based applications that extend the capability of spreadsheets by defining variable inputs in terms of ranges of possible values. Once the sources of risk are identified, Crystal Ball can be used to calculate potential outcomes, using Monte Carlo simulations.

(2) Modeling Risk into Well-Defined Distributions

Quantifying risk begins with the application of well-defined probability distributions to an estimate. These distributions are used to quantify the range of possible outcomes caused by variance or error in the estimate's variables and CERs. To that effect, each software package described in the previous section offers an array of distributions for modeling such risk. Some of the most commonly used distributions are as follows:

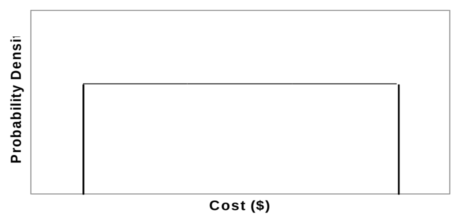
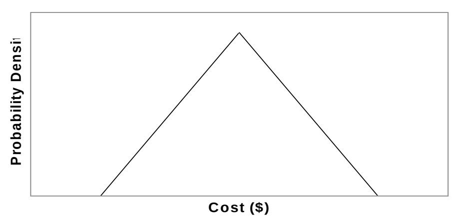
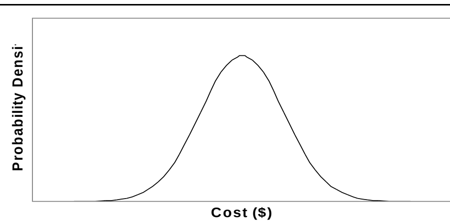
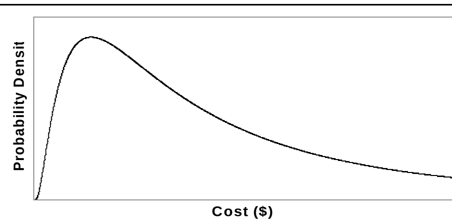
a. Uniform Distributions are used when low and high estimates are available, but there is no indication that any point between them is more probable than any other.

b. Triangular Distributions are frequently used in applying risk, since they require only three inputs but are more descriptive than the uniform distribution. A triangular distribution can be skewed or symmetrical, and has its peak at the most likely value (point estimate), with a linear taper on either side to the low and high values.

c. Normal Distributions are characterized by a symmetric single-peak bell curve and are determined by two parameters. The sample mean (point estimate) serves as the center of the curve and the sample standard deviation indicates the spread. As the standard deviation increases, the spread increases. This distribution is more descriptive than the previous two and is most often used to describe the error term around linear CERs. It may also be used when data exhibits sufficient mathematical characteristics of a normal distribution or when such an assumption is otherwise appropriate.

d. Lognormal distributions are used to describe risk for power functions or log-linear CERs. This type of distribution represents data that follows a normal distribution after logarithmic transformation. As described in Figure 12.1, the scaling/sizing parameters of the lognormal distribution are the logarithm of the same parameters of the underlying normal distribution. This distribution is always skewed right; as the standard deviation increases, the skewness increases as well.

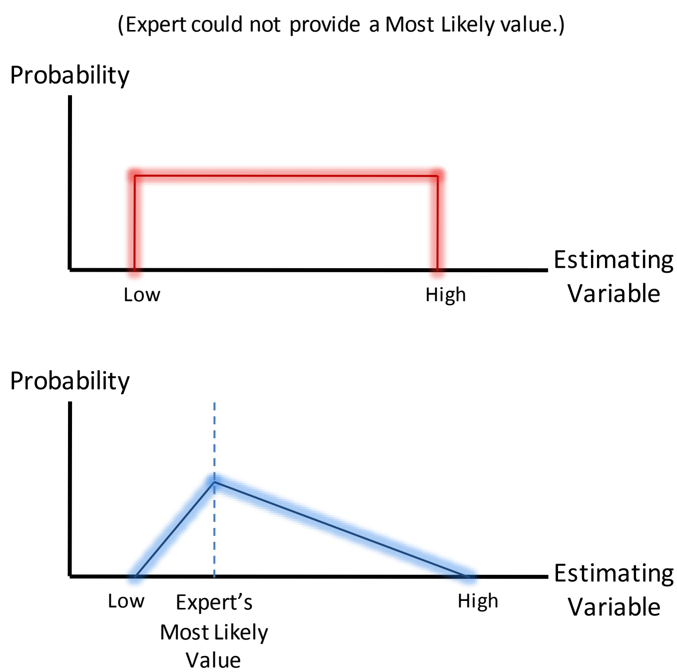
Figure 12.1 – Common Probability Distribution Descriptions

Common Distributions		Data Required
Uniform All values within the range have an equal likelihood of occurrence.		Low High
Triangular Likelihood of occurrence decreases with distance from point estimate. Easy to understand and communicate with experts.		Low Most Likely = Mode High
Normal Likelihood of occurrence decreases with distance from point estimate. Equal probability of overrun and underrun.		Mean Standard Deviation
Lognormal The uncertain variable is greater than some finite limit but can increase without limit. Most values are near the mode.		Mean Standard Deviation (Of Underlying Distribution)

(3) Approaches for Applying Distributions to Various Types of Point Estimates

a. ***Expert Opinion*** estimates are provided by a subject matter expert with extensive knowledge of the subject at hand. With this type of estimate it is likely that there will only be enough information to select either the uniform or triangular distribution. At a minimum, the expert must identify a lower bound and an upper bound to use the uniform distribution. When the expert can also provide a most likely value within that range, the triangular distribution may be used (see Figure 12.2). Distributions should be defined for each separate variable estimated by the expert.

Figure 12.2 – Uniform or Triangular Distribution for Expert Opinion



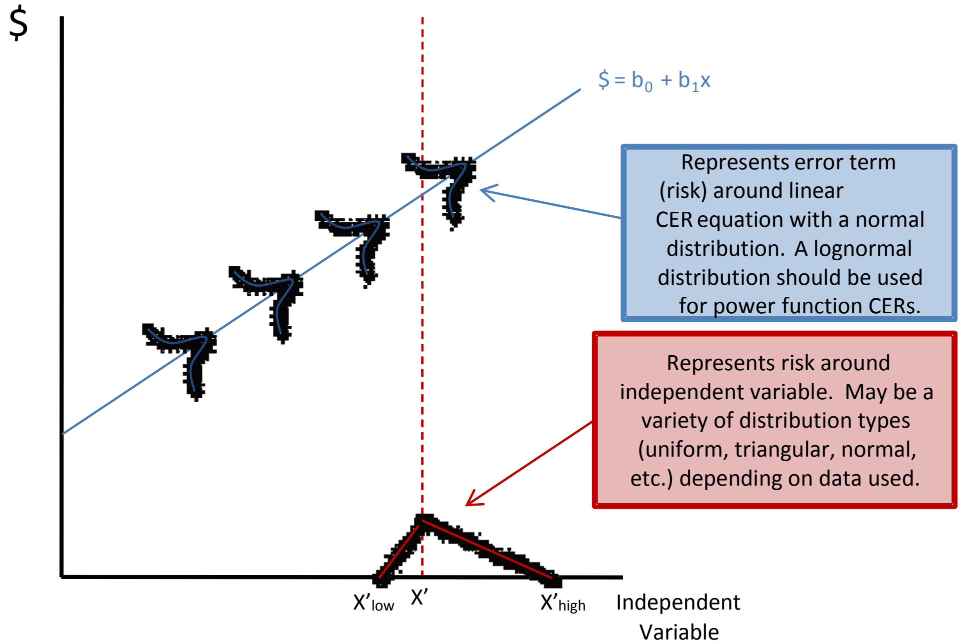
b. ***Analogy*** estimates are made by comparing the unknown system to historical data of one or more analogous systems. An adjustment factor may be suitable when using this method to account for differences between the unknown system and the analogous system(s). Distributions can be defined for an analogy estimate to estimate the variance in both the adjustment factor *and* the cost of the analogous system.

Cost of Unknown System = Cost of Analogous System * Adjustment Factor

A risk distribution can be defined for the adjustment factor based on the methodology used to formulate it. In other words, the adjustment factor is treated as a separate estimate, and a distribution applied according to its methodology (Expert Opinion, Analogy, Parametric, or Engineering). The variance related to the cost of the analogous system depends upon the data used. If the actual cost for the analogous system is not certain, then a uniform, triangular, or normal distribution can be used to model that risk. If the data used to derive the cost of the analogous system was based on contract data with little doubt as to its accuracy, then the variance may be negligible and a distribution unnecessary.

c. ***Parametric (CER)*** estimates are done using estimating equations which are derived statistically from historical data of analogous systems. The independent variables of the CER equation drive the estimate. Risk distributions can be defined to account for both the risk in the independent variables *and* the statistical estimating error surrounding the CER (see Figure 12.3). The risk for each of the independent variables is treated as a separate estimate, and distributions for each are defined according to the methodology used to determine their value (Expert Opinion, Analogy, Parametric, or Engineering).

Figure 12.3 – Risk in Parametric Estimates



The statistical estimating error surrounding the CER can be defined using a normal or lognormal distribution. The statistics reported with the CER will usually provide normal distributions if the CER is linear. Lognormal distributions are typically provided by the analysis accompanying log-linear and power function CERs.

d. ***Engineering*** estimates are built from the bottom up using actual costs taken from contracts, contractor cost reports, purchase orders, etc. Any estimated value not based on negotiated actual costs may be uncertain going into the future. Distributions can be defined for such values according to how they were derived. For example, if a program has yet to select a contractor and is uncertain regarding future overhead rates, then a distribution should be added to any estimate of overhead rate to account for the various possible outcomes. This may be done using a CER formed from historical data, a program expert's opinion, or analogy to another program.

(4) The Impact of Correlation across Variables

Even if it were possible to accurately represent all the risks and uncertainties involved in the individual variables in the estimate, this would not account for the full range of cost variance of the program. This is due to *correlation across variables*.

When a software package is representing program risk, the estimating software selects random values from each lower level distribution in the estimate to formulate a data point. It does this through hundreds or thousands of iterations as defined in the software, each iteration forming another data point. These data points are then combined to formulate a single risk distribution at the higher level. To understand the impact of correlation across variables, suppose two variables within Procurement are highly correlated so that an increase in one variable corresponds to an increase in the other, but their risk distributions have been independently assigned. If, when calculating the total risk distribution for Procurement, a simulation randomly selects a value for the first variable that is well above its point estimate, then it should consequently select a value for the second variable that is also well above its point estimate, because the variables are positively correlated. However, when the two cost elements are not defined—within the simulation—as highly correlated, that will not happen. As a result, an increase in one variable may be cancelled out by a decrease in the other and the total risk distribution for Procurement will be too narrow.

The software packages listed (ACEIT, @Risk, and Crystal Ball) allow the analyst to input correlation between variables after an estimate has been completed. Depending on the methodologies used, some of the interdependence between variables may already be accounted for by the model structure. For example, Sustaining Tooling costs may be estimated as a factor of Recurring Manufacturing because the two cost elements are highly correlated. Since the elements are linked by their estimating methodologies, the correlation between them is already accounted for. If correlation is not accounted for by the model design, analysts should address it by inputting correlation between variables through their specific software package.

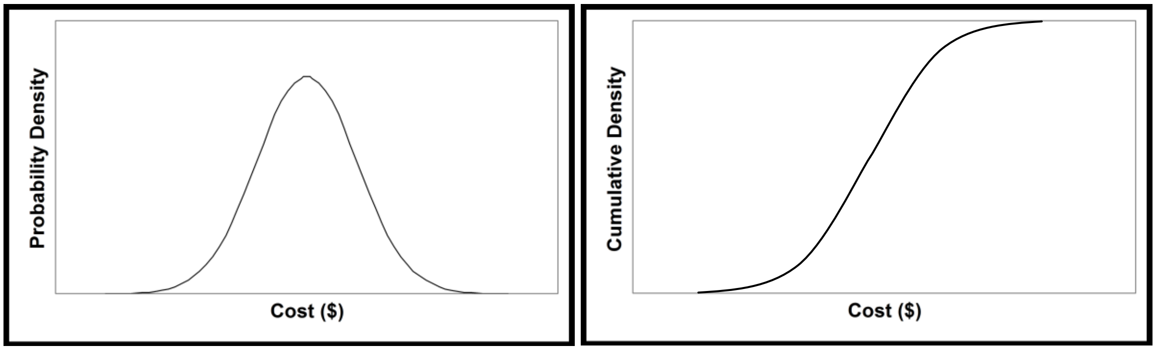
(5) Formulating an S-Curve

The probability distributions shown in Figure 1.0 are referred to as Probability Density Functions (PDFs). The area under each PDF is equal to 1, meaning that each distribution captures 100% of the possible outcomes defined by the distribution's parameters. Each point on the PDF curve represents the probability of that particular cost (or other value) occurring.

After defining PDFs for all significant areas of risk identified within the estimate, the analyst can use one of the software tools mentioned earlier (ACEIT, @Risk, or Crystal Ball) to formulate a Cumulative Density Function (CDF), also known as an S-Curve (see Figure 12.4). Each point on the S-Curve identifies the cumulative probability that the associated cost on the x-axis will not be exceeded. This is also referred to as the *level of confidence* in a particular estimate.

Adding PDFs to an estimate and calculating an S-Curve *does not alter the point estimate* but rather allows the analyst to determine the level of confidence that the actual costs will not exceed the point estimate (or other chosen cost). S-Curves can be formulated at any level of detail the analyst determines necessary for presentation. For example, they may be formulated for each individual cost element if more detail is desired or for each individual appropriation if less detail is desired.

Figure 12.4 – Example PDF and CDF (S-Curve)



The S-Curve allows the estimator to address the following questions:

a. What is the level of confidence in the point estimate given the assumptions used during the risk analysis? In the table below, the point estimate shows a 38.5% confidence that the program's actual cost will not exceed $55.0M.
b. How much funding is needed in order to reach various levels of confidence such as 40%, 50%, etc.?

Confidence Level	Funding Level ($M)
30.0%	$35.1
38.5% (Point Estimate)	***$55.0***
40.0%	$58.4
50.0%	$69.2
60.0%	$76.3
70.0%	$84.9
80.0%	$97.0
90.0%	$125.5

Two limitations of S-Curves should be remembered:

a. The curve only represents the risks and correlations which have been included in the model. There is no new information in the curve which was not in the model. The curve only displays the information which has already been represented.
b. Putting the information in the form of a graph with labels does not make that information any more accurate. The unknowns and uncertainties in the model are still there. Having a computer-generated graphic does not eliminate unknowns.

Section 12.4 – Presenting Risk and Uncertainty

(1) Audience

Tailoring the Presentation to the Audience

The goal of presenting Cost Risk and Uncertainty Analysis varies based on the audience. Each audience has its own unique requirements for information and its own priorities in decision-making. Presentations of Cost Risk and Uncertainty Analysis may include a variety of audiences, including (but not limited to) the following common stakeholders:

- Program Executive Officer
- Program Manager / Project Manager
- Business Manager
- Cost Chief
- Joint Cost Team or Cost Integrated Product Team
- Office of the Deputy Assistant Secretary of the Army for Cost and Economics (DASA-CE)
- Cost Analysis Improvement Group (CAIG) Analysts or Chair
- Cost Review Board Working Group (CRBWG)
- Cost Review Board (CRB)

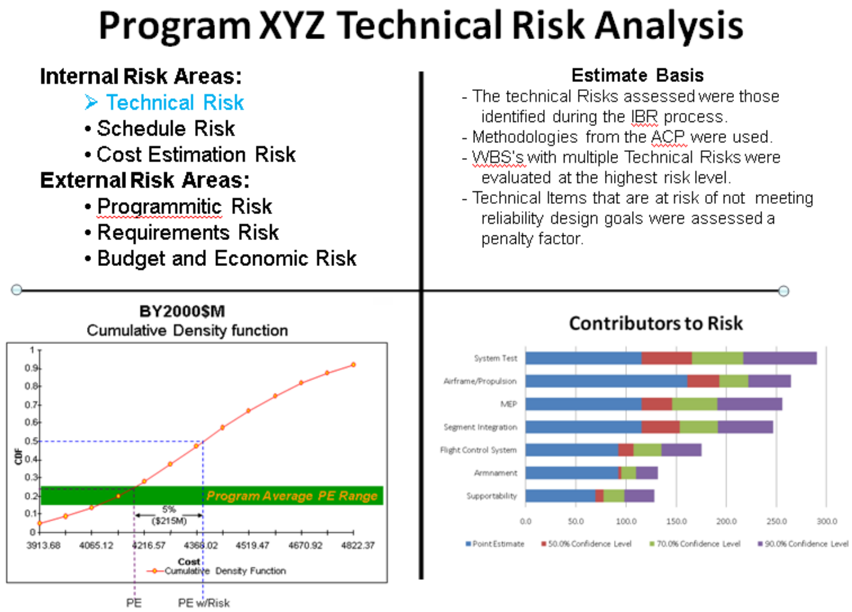
Cost risk analysis should be done according to the guidance laid out in *Identifying Risk and Uncertainty* and *Quantifying Risk and Uncertainty* (Sections I and II). However, the presentation of that analysis, and the cost risks addressed in it, should be tailored to the level of detail needed by each particular audience. For example, Program Managers may need top-level information to make decisions about how to manage risk while CRB members may need more detailed information to analyze the assumptions and calculations in the estimate.

Presentations of cost risk and uncertainty should include an explanation of the various uncertainties captured in the estimate and the uncertainties not captured in the estimate. For example, risk distributions used in an analysis may have intentionally excluded the possibility that certain Key Performance Parameters (KPPs) would not be met. Stating such assumptions upfront will help prevent the audience from misinterpreting the analysis provided.

a. *Example Presentation Quad-Chart*

Figure 12.5 shows one way to set up a report on a cost risk analysis. This type of display can be used to highlight which risk areas are being addressed.

Figure 12.5 – Example Risk Analysis Chart



In this layout, the four quadrants should contain:

1. Top Left Quadrant - Risk Areas, with markers indicating which risk areas are considered.

2. Top Right Quadrant – Assumptions

3. Bottom Left Quadrant
    a. S-Curve
    b. Point Estimate
    c. Mean
    d. 50% Confidence Level
    e. Any Upper Confidence Levels of Interest

4. Bottom Right Quadrant
    a. Top Risk Cost Elements (i.e. System Test)
    b. Cost Element Point Value
    c. Cost Elements ranked by potential impact

When cost estimates are provided to audiences other than the CRB, the presenter can decide how to present the information.

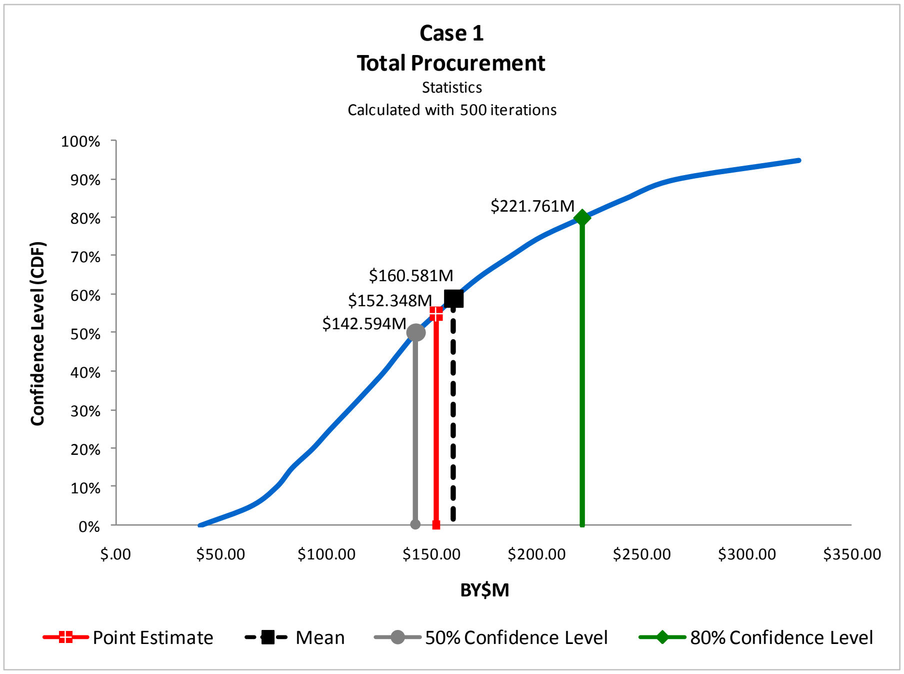
b. ***Presenting an S-Curve and Selecting a Confidence Level***

As noted earlier, the S-Curve displays the range of possible costs for a program based on the risk distributions for each variable and gives a level of confidence for each cost chosen by the analyst, including the point estimate. S-Curves may be formed at any level of a cost estimate (individual cost elements, full appropriations, etc.) depending on the level of detail needed by the audience.

The point estimate in Figure 12.6 is at the 55% confidence level, meaning there is approximately a 45% chance of overrun based on the assumptions in the analysis. The point estimate should usually be highlighted in an S-Curve. In this example, other highlights show different levels of funding required for specific levels of confidence.

Figure 12.6 S-Curve Example

(This example is similar to an S-Curve chart that can be made using ACEIT/POST software.)



3-5f.i.

Selection of Confidence Level	Cost Estimate
50% Confidence	$142.6
55% Confidence (Point Estimate)	$152.3
58.8% Confidence (Mean)	$160.6
80% Confidence	$221.8

The lower the confidence level selected by the decision maker, the greater the risk taken by the program that an overrun will occur. To protect against an overrun, *Risk Dollars* may be added to the point estimate to get to a higher level of confidence. *Risk Dollars* are defined as the difference (in dollars) between the point estimate and the confidence level selected by the program.

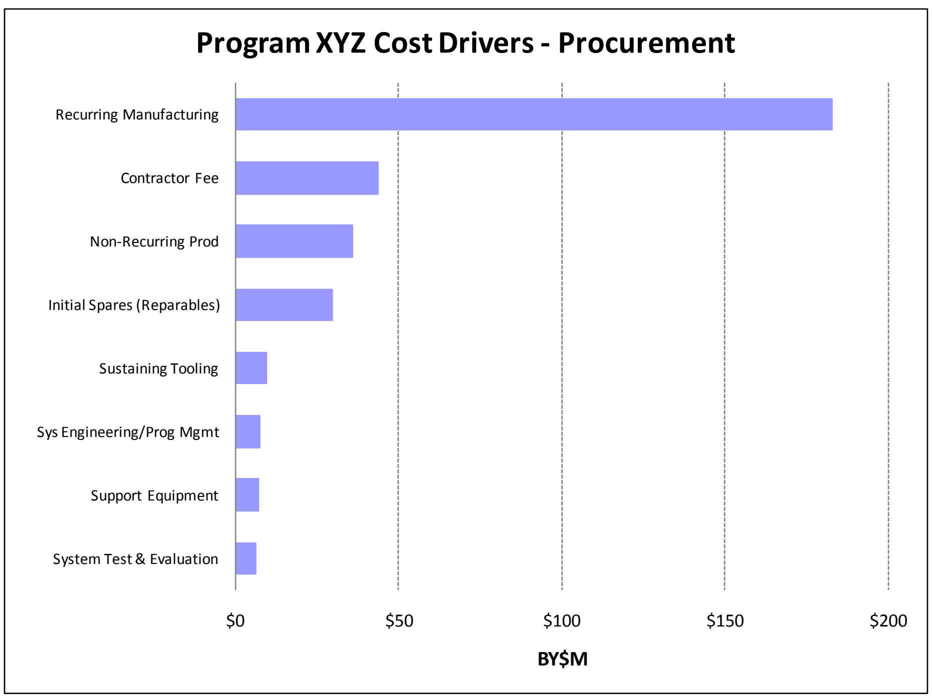
c. ***Other Useful Information for Briefing***

In addition to the S-Curve, there are several other ways to present an analysis of cost risk and uncertainty. The following tools may be used in addition to an S-Curve depending on the level of detail needed by the audience:

i. *Analysis of Cost Drivers* – Analysis of cost risk and uncertainty is built upon the foundation of a solid point estimate. As a result, a list or graphical representation of cost drivers in the point estimate may be useful when presenting cost risk and uncertainty. Figure 12.7 shows a Pareto Chart created to graphically represent the cost drivers of a particular program's Procurement estimate.

Figure 12.7 – Pareto Chart

(This example is similar to a Pareto Chart that can be made using ACEIT/POST software.)



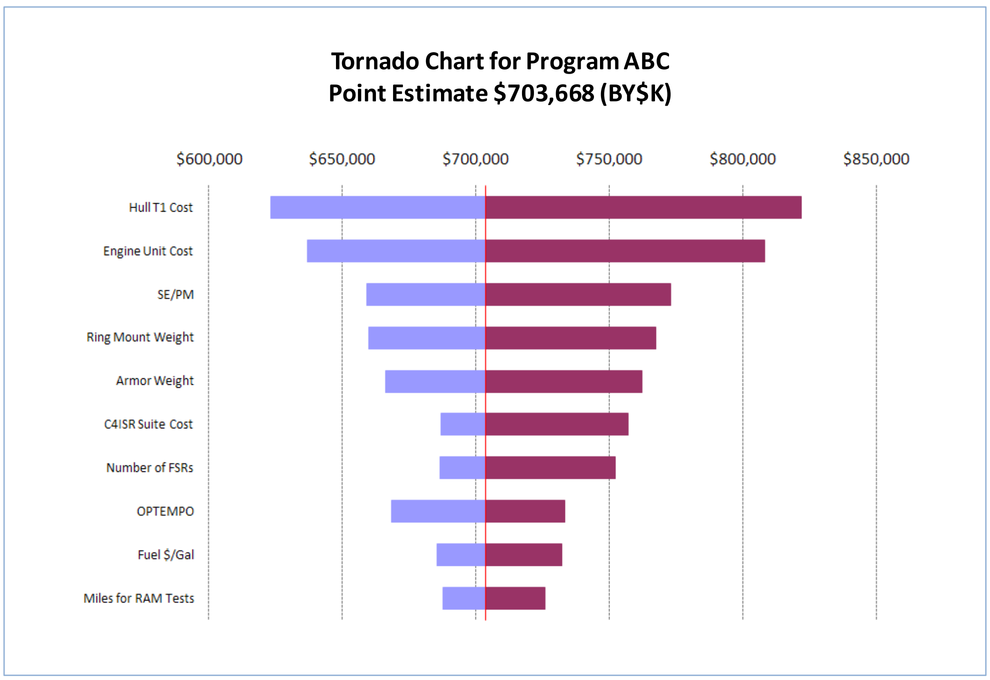
ii. *Explanation of How Risk was Defined* – The addition of risk distributions to underlying variables determines the shape and range of the S-Curve that the audience will see. A brief explanation of how those distributions were defined, followed by a few examples, can introduce the audience to the process of Cost Risk and Uncertainty Analysis.

iii. *Identify Most Important Risk Drivers* – The audience may need to know which risks contribute the most risk to the program. This can provide valuable information to decision-makers about how to mitigate cost risk. One way to present the risk drivers is through a tornado chart like the one seen in Figure 12.8.

A tornado chart shows the impact input variables have on the cost estimate. In the graph below, the top ten drivers have been chosen. The longer the bars, the greater the risk and potential impact to the program's cost.

Figure 12.8 – Tornado Chart

(This example is similar to a Tornado Chart that can be made using ACEIT/POST software.)



iv. *Then-Year Risk-Adjusted Estimates* – Decision-makers who are selecting a confidence level at which to fund the program may want to see where the dollars would fall in the budget. A variety of options for phasing risk dollars is available (as discussed later in this section). Displaying these options through then-year risk-adjusted estimates will show where the risk dollars fall. The presenter may even need the decision-maker to choose amongst these options to select a method for phasing risk dollars to protect against particular risks.

(2) Distributing Risk Dollars within the Cost Element Structure (CES)

After a confidence level is chosen and risk dollars have been computed, those risk dollars must be added to the estimate. The first step to adding risk dollars to an estimate is determining at what level in the CES to add them. The appropriate placement of risk dollars will depend on the purpose of the particular analysis. For some purposes, risk dollars will need to be reported in aggregate; for others, risk dollars are better added into the individual elements in the estimate structure. A good risk analysis should allow various options for the allocation of risk dollars, so it supports various types of reporting.

Wherever risk dollars are added in the estimate, they must be clearly visible. Decision-makers and other potential audiences should be able to do the following when viewing the cost estimate:

a. Determine whether or not risk dollars have been included in the estimate.
b. Determine which risks are represented in the analysis, and which risks and uncertainties are not represented.
c. Determine the amount of risk dollars added at various levels.
d. Determine the level of confidence in the risk-adjusted estimate.

(3) Phasing Risk Dollars over Time

After deciding the appropriate level of the CES for adding risk dollars, the next step is to phase those risk dollars over time. The dollars can be spread over time using a variety of techniques. The following techniques are commonly used:

a. *Pro-Rated According to the Point Estimate*
   In this technique, risk dollars are spread in direct proportion to the estimate. More risk dollars are added in years with more funding. Software packages used to estimate risk may automatically default to this phasing method. This is rarely a realistic placement of risk dollars, but it can be used in the absence of information to support a more specific breakout.

b. *Defined Curve Over a Specified Range of the Estimate*
   Fitting a specified distribution (uniform, normal, beta, etc.) is useful when there is reasonable insight into the timing and impact of program uncertainties. Risk dollars may be spread over all years of the estimate or a specified range of years within the cost estimate.

c. *Phased in Specific Years of the Estimate*
   Risk Dollars can also be spread across the estimate as determined by the PM or analyst. This method allows dollars to be spread in the estimate to guard against particular risks that are well-known. For example, the PM may be particularly interested in protecting against cost overruns and delays in production of LRIP units. To protect against this risk, the analyst would spread extra Risk Dollars within the years in which LRIP units were being produced.

d. *Extending the Schedule*

When risks are realized it is typically in the form of cost and schedule. Additionally, risks are not usually realized early in the program so by the time the risk is realized there is less time in the schedule to resolve problem. Once the cost risk analysis is completed it may not make sense to confine the phasing of all of the risk dollars to the current program schedule. If the magnitude of the cost risk dollars that need to be added to the program is large it may make sense to phase the risk dollars beyond the program's projected completion date. If the schedule is extended the program's fixed costs (SE/PM) should also be increased. This method addresses both cost and schedule risk.

Section 12.5 – Summary

This chapter has introduced analysts to the process of identifying, quantifying, and presenting a program's risks and uncertainties as assessed within its Life-Cycle Cost Estimate. After subjectively identifying and analyzing the program's major uncertainties, the analyst must quantify the variability of their underlying point estimate. Once all major uncertainties are quantified with distributions, a variety of charts, tables, and graphs can be made to help present the program's cost risks to an interested audience or decision maker.

When beginning a Life-Cycle Cost Estimate, the analyst must always begin assessing the program's cost uncertainties as soon as possible, making sure that distributions are developed right alongside point estimates. Also, the analyst must be careful to keep in mind the limitations of Cost Risk and Uncertainty Analysis. Uncertainties that were not quantified in the analysis cannot be accounted for in the final risk assessment, so there is no way to adjust the budget to protect against such risks.

If this process is followed carefully, the analyst will be able to disclose valuable information to decision makers to improve the budget process and protect against unwanted outcomes. Once completed, a cost estimate that includes an analysis of risk and uncertainty will paint a more accurate picture of the program's future costs than a simple point estimate.